# Sports Tips & Tricks: Distal Triceps Tendon Knotless Anatomic Footprint Repair

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## Background

Distal triceps tendon tears are a rare injury accounting for only 0.8% of reported tendon injuries[1]. The injury is most commonly seen in men (2:1 ratio) ages 30-50 and occurs most frequently due to bodybuilding, competitive weightlifting, and football. The greatest risk factors are anabolic steroid use and weight lifting[2]. Other risk factors include local corticosteroid injections, olecranon bursitis, metabolic bone disease (hyperparathyroidism, renal disease), rheumatoid arthritis, type 1 diabetes, and Marfan syndrome[3,4].

The mechanism of injury is most commonly a sudden eccentric load applied to a contracting triceps muscle, such as during weight lifting or a fall on an outstretched hand. Other less common mechanisms include laceration, direct blow to the posterior elbow, and open fracture[5]. Tendon tears typically occurs at the tendon insertion into the olecranon[6], although there are reports of tears at the myotendinous junction or within the muscle belly itself[7].

Management of distal triceps tendon tears is based on the degree of tendon tear and elbow extension loss of function. Partial tears are repaired based on the functional needs of the patient taking into account medical comorbidities. In general, patients with <50% tendon tear can be treated conservatively with acceptable outcomes, as well as patients with >50% tears that are sedentary[8]. Active patients or those with complete tears are treated surgically. Ideally, tendon repair would occur within 2 weeks of the injury.

Conservative management consists of initial splint immobilization at 30 degrees of flexion, followed by progression to passive then active range of motion and strength training. Most properly selected patients treated conservatively will return to their pre-injury level of activity[9].

Surgical management involves primary repair of the distal triceps tendon to the olecranon. The tradition approach for repair has been the transosseous tunnel technique where nonabsorbable sutures are placed in the distal tendon using a Krackow or similar locking stitch, followed by passing the sutures through transosseous tunnels drilled in the olecranon, then tying the sutures over a bone bridge[5]. However, cadaveric studies have shown that the triceps insertion on the olecranon is rather expansive and traverses a wide footprint on the olecranon[10]. The footprint commences 12 mm distal to the tip of the olecranon and blends with the posterior capsule. Biomechanical studies showed that the transosseous tunnel repair technique only covered 31% of the anatomic footprint of the tendon. Therefore, alternative techniques were developed to create a more anatomic repair of the tendon.

Alternative techniques included a double row suture anchor technique similar to rotator cuff tendon repairs[10] and a knotless anatomic footprint repair that uses bone tunnels and creates a "box-and-x" suture configuration to compress the tendon over the tendon footprint on the olecranon[11]. Initial biomechanical studies comparing the transosseous tunnel technique to the knotless anatomic footprint repair technique showed that the knotless anatomic repair technique increased the footprint coverage to 74%[12]. In addition, the knotless anatomic technique resulted in less displacement after cyclic loading, higher peak load, and higher load at yield than the transosseous tunnel technique. However, functional outcome studies comparing the two techniques showed no clinically significant difference between the two techniques[13]. A more recent biomechanical study pointed out the fact that prior studies comparing the two techniques used different numbers of sutures in the triceps tendon. When those studies were repeated using the same number of sutures for the two techniques, no significant difference was found in cyclic load displacement[14].

## Case Report

A 15 year old right-handed male that presented with an injury to the left arm after being tackled while playing football 1 week ago. His exam was notable for 3/5 elbow extension strength and a palpable gap in the triceps tendon insertion. Although not specifically noted for this patient, other common physical exam findings for a distal triceps tendon tear include elbow pain, swelling, and ecchymosis. Inability to extend the elbow actively is a sign of complete tear, although some patients with a complete tear of the distal triceps tendon are still afforded some extension due to an intact lateral triceps expansion. In fact, 50% of

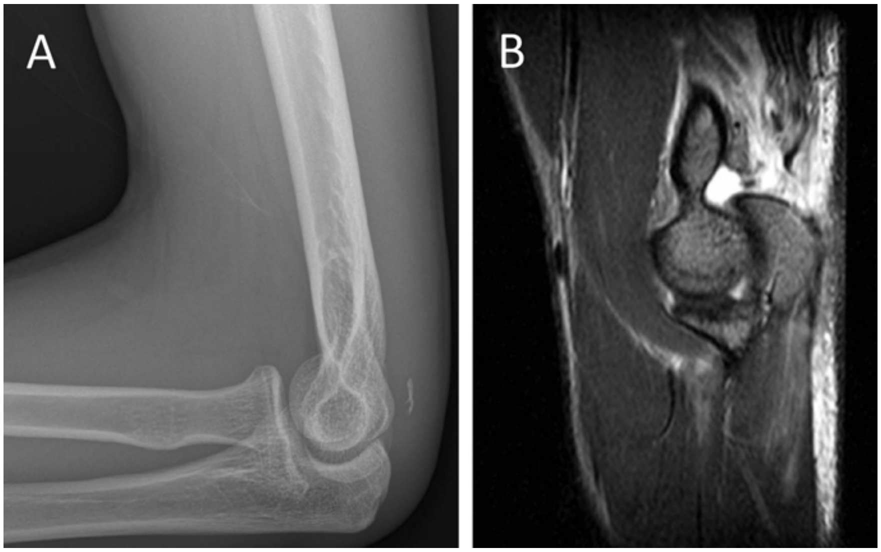


**Figure 1.** Imaging of left elbow. **(A)** Radiograph of the lateral elbow showing a flake of bone avulsed from the olecranon indicating a triceps tendon tear. **(B)** STIR MRI of the left elbow showing a fluid gap between the olecranon and distal triceps tendon consistent with a triceps tendon tear.

acute triceps tendon tears are misdiagnosed because of active elbow extension due to the lateral triceps expansion[6].There is also a modified Thompson squeeze test for triceps tears that is analogous to the test for Achilles tendon tears that can aid in the diagnosis[5]. For higher energy injuries, it is important to do an ulnar nerve exam and check all arm compartments as well[15].

Imaging for the patient is shown in Figure 1. On the lateral X-ray of the elbow in Figure 1A, there was a positive 'flake sign' that indicates avulsion of bone from the olecranon. This is almost always pathognomonic for a distal triceps tendon tear. The MRI image in Figure 1B confirmed the distal triceps tendon avulsion. Ultrasound can also be used to evaluate the integrity of the triceps tendon and determine if the tear is partial or complete. Since the patient was young and active with a loss of elbow extension strength and a confirmed distal triceps tear on MRI, surgical repair of the tendon was indicated and the knotless anatomic footprint repair technique described below was used.

For the procedure, the patient is positioned in the lateral decubitus position using a bean bag with the left arm draped over an arm bolster. A posterior approach to the elbow is used with a midline incision that curves slightly radial to the olecranon to prevent scar formation directly over the tip of the olecranon. Full thickness skin flaps are raised radially and ulnarly. The distal end of the torn triceps tendon is identified and debrided. The tendon footprint on the olecranon is then identified and debrided down to bleeding bone to aid in healing.

The triceps tendon is freed of any adhesions to aid in mobilizing the tendon. Two No. 2 FiberWire (Arthrex, Naples, Fla.) sutures, one medial and one lateral, are passed through the tendon using a locking Krackow stitch both starting and ending at the proximal aspect of the tendon footprint on the deep aspect of the tendon (Figure 2A). In addition, two FiberLink (Arthrex, Naples, Fla.) sutures are placed medial and lateral at the proximal aspect of the tendon footprint. The looped ends of the FiberLink sutures are on the superficial side of the tendon.

Two parallel tunnels are drilled through the olecranon using a 2.4 mm drill bit. The tunnels start at the proximal footprint of the tendon on the olecranon aiming distally towards the posterior ulna. The distance between the two tunnels is wide enough to place a 4.75 mm SwiveLock (Arthrex, Napes, Fla.) suture anchor. Once the tunnels are drilled, the ulna is drilled and tapped just distal to the exit point of the tunnels for the suture anchor with the trajectory directed away from the joint.

Once the bone tunnels are drilled, the sutures are passed using a Hewson suture passer. The three medial sutures (two FiberWire and one FiberLink nonlooped end) are passed through the medial tunnel, and the three lateral sutures are passed through the lateral tunnel (Figure 2B). One of the medial FiberWire tails is then placed through the lateral FiberLink looped end and passed through the lateral bone tunnel. The same is done for one of the lateral FiberWire tails to pass through the medial bone tunnel (Figure 2C). This creates a "box-and-x" configuration to compress the tendon over the footprint (Figure 2D). The FiberWire sutures (2 medial, 2 lateral) are then tensioned and passed through the eyelet of the 4.75 mm SwiveLock suture anchor and the anchor is placed in the prepared hole in the olecranon (Figure 2E). Final tensioning is done before screwing the anchor into the olecranon until it is flush with the bone. The incision is then closed and the patient is placed in a posterior splint.

Post-operatively, the patient remains in a splint for 2 weeks and then the sutures are removed. The patient is transitioned to an elbow brace and allowed to perform passive range of motion exercises starting at 0 to 45 degrees and increasing flexion by 10 degrees each week. The goal is to reach full range of motion by 6-8 weeks post-operatively, at which point the elbow brace can be discontinued. At that point, the patient can begin strength training. Return to work or sports is not recommended until patient has full range of motion of the elbow and 85% of the strength of the contralateral side.

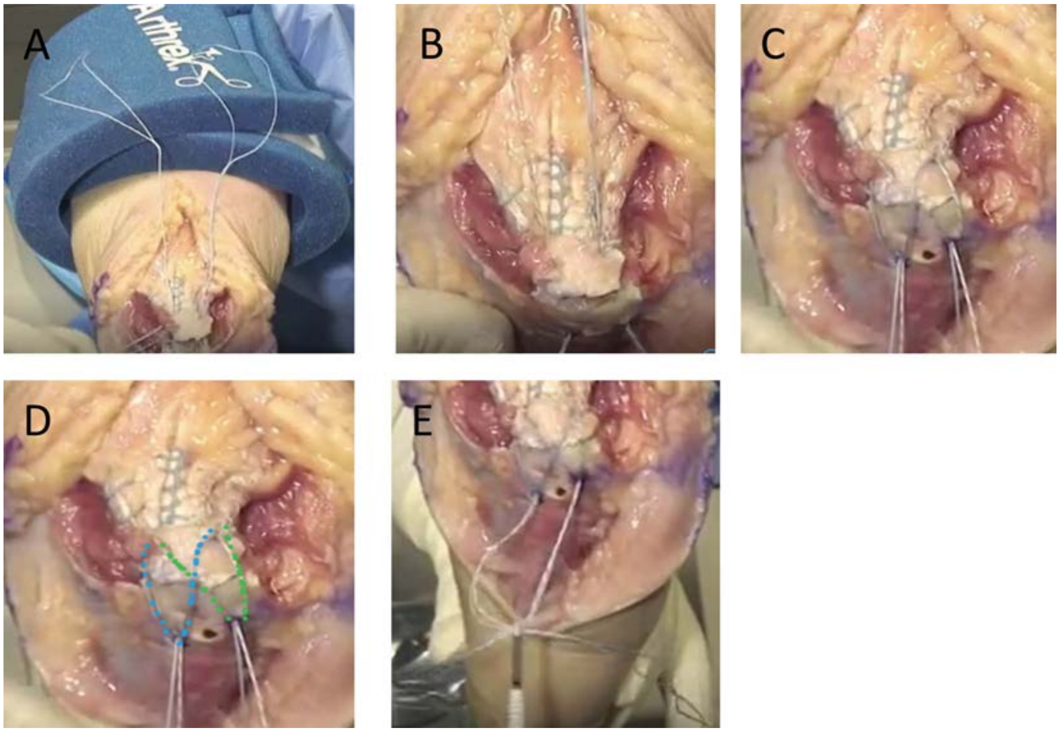


**Figure 2.** Suture passing technique demonstrated on a cadaver[16]. **(A)** Two FiberWire sutures, one medial and one lateral, are passed through the tendon using a locking Krackow stitch. Two FiberLink sutures are placed medial and lateral with the looped ends of the FiberLink sutures are on the superficial side of the tendon. **(B)** FiberWire sutures are passed through the parallel bone tunnels using a suture passer. **(C)** One FiberWire suture on each side is placed through the opposite side FiberLink loop and passed through the opposite tunnel. **(D)** Illustration of how one of the FiberWire sutures is passed through the opposite bone tunnel to create the "box-and-x" configuration over the tendon footprint. **(E)** FiberWire sutures are tensioned and passed through the eyelet of the SwiveLock suture anchor before being placed in the prepared suture anchor hole.

## Discussion

Distal triceps tendon tears are relatively rare tendon injury seen most commonly in middle aged men and associated with weight lifting and playing football, although other mechanisms include lacerations, open fractures, and direct blows to the posterior elbow. The injury can be treated conservatively or surgically depending on whether the tear is partial or complete, the degree of functional loss, and the demands of the patient. Surgical techniques include transosseous tunnels and the knotless anatomic footprint repair. Biomechanical studies have shown that the anatomic footprint repair results in a greater coverage of the tendon footprint on the olecranon, but cyclic load displacement is similar between the techniques when the same number of sutures is used. Functional outcomes are similar between the two techniques with the knotless technique perhaps more facile as transosseous tunnels are avoided.

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